THE USE OF GLOBAL POSITIONING AND GEOGRAPHIC INFORMATION SYSTEMS IN WETLAND ALTERATION SITE VISITS

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INTRODUCTION

History

In the early 1980s, the Maine Department of Marine Resources (DMR) was conducting a Marine Resources Inventory Project. The Inventory Project, funded by the Maine Department of Environmental Protection (DEP) and the Maine State Planning Office, was initiated in response to the threat of marine oil spills. Its primary focus was to identify, survey, catalogue and map marine resources at risk to oil spills for mitigation and damage assessment purposes. At this time the State of Maine was looking into the adoption of a Geographic Information System. Because resource mapping was one of the major tasks of the Inventory Project, the principal investigator was asked to participate in a series of meetings, workshops and conferences on Geographic Information Systems (GIS).

The value of GIS was not lost on the Administration at the time and eventually the state adopted what has become a comprehensive and robust program under the Office of GIS. Unfortunately, development of the technology and infrastructure was too long in coming for the DMR Resource Inventory Project, which was abandoned in the mid 1980s.

The development of the satellite based Global Positioning System (GPS) and its subsequent refinement during the late 1990s vastly improved the versatility of GIS by providing real time, precise location data from the field. Data logging GPS receivers soon became a major contributor to the data collection process.

In mid 2000, the DMR Watershed Division obtained a Trimble GeoExplorer 3 data logging GPS unit with Pathfinder Office GIS software. A Watershed staff member had also been the principal investigator with the Resource Inventory Project and saw the acquisition of the GPS unit and GIS software as the opportunity to develop a valuable tool for the division.

GPS-GIS Project

The Watershed Division is responsible for wetland alteration permit reviews. One aspect of the Watershed Division's mission in which the GPS-GIS combination could prove useful is permit review site visits. Permit review site visits are conducted to characterize sites of proposed wetland alteration projects such as pier construction and shoreline stabilization. A marine biologist is responsible for describing the geologic environment of the shore from the adjacent upland to the subtidal zone. Major flora and fauna are also described. A determination is made as to the probable effects of the project on the environment and mitigation strategies suggested if necessary. All of this information is documented and provided to the Department of Environmental Protection. The DEP is responsible for issuing a permit for the project if it meets approval criteria.

The goal of this project was to examine the feasibility of using GPS and GIS to enhance the site visit process. In order to accomplish the objective it was necessary to establish the necessary procedures for their use and to develop appropriate products in addition to those currently provided. This report documents those efforts. Please note, however, that it was beyond the scope of this report to describe GPS and GIS and it is assumed that the reader has some basic knowledge of them.

OVERVIEW

Hardware

The GPS unit used in this project was the Trimble GeoExplorer3®. The GeoExplorer is a "data logging" unit that is capable of data input and storage. When in the field, spatial data (location and elevation) and time are obtained from the constellation of GPS satellites and stored in the unit. Other data can be inputted by keyboard if the unit is programmed to accept it. Once field operations are completed, the data can be downloaded to a computer for processing. The computer used in the project was an IBM ThinkPad®.

Software

The companion software for the GeoExplorer is Pathfinder Office® (2.51). The software has both GPS and GIS functionality. Prior to fieldwork, the software is used to create, and upload to the GPS unit, a data dictionary that is a set of attributes in the form of scroll down lists. In the field the data dictionary is used to input data (choose an menu item or enter a number for each attribute) at each location (feature). Back in the office the software is used to download and process the data from the GPS unit. The software is also used to manage and display the data.

GPS Setup

In order to utilize GPS and GIS for wetland alteration site visits, a data dictionary had to be created using Pathfinder. There are 44 datum recorded at each site (feature). Date, time and location are automatically recorded; the remainder must be entered. The entered data include the geologic environments of the upland, intertidal and subtidal areas as well as characteristic flora and fauna. Each datum, or attribute (e.g., 'Upper Intertidal', 'Intertidal Width'), could have as many as 17 menu items to choose from or simply a number input (e.g., 'sand' for the former, '60' for the latter). Once the data dictionary was created and uploaded to the GPS unit, fieldwork could begin. Table 1 is a schematic of the 'Wetlands Data Dictionary'.

Field Work

The collection of data in the field for wetland site visits was fairly easy. Once at the site, the GPS unit is activated and in a few minutes will initialize (acquire enough satellite transmissions to calculate a position). Before recording position information, the data dictionary is accessed and attribute data recorded. Upon completion of data input, the location-recording feature is activated at a suitable location (i.e., high tide line at mid-site) and allowed to operate for at least a minute. Shutting down the GPS unit completes the fieldwork.

Office Work

Back in the office, data can be downloaded from the GPS unit into the computer with the GIS software. The software is then used to perform a number of functions including data processing, management, display as well as export to other GIS programs.

Using the software, the location information can be made more accurate through differential correction. Differential correction is a process that uses GPS signals received by a local fixed based station at the time of data collection to correct for aberrations to the signal due

to atmospheric conditions and other forms of interference. The corrections are obtained from the base station through the Internet.

The software will display the corrected location data as a point or points on a background map (topographic map previously downloaded from the Internet). This map can be printed with formatted information such as title, lat/long, scale bars and etc. In addition, an information box can be opened which shows all of the attribute data for each point.

The data can be exported to a database manager for further processing. The data can also be exported as files suitable for other GIS programs such as ArcView®.

PROCEDURES

This section describes the specific procedures developed for use in wetland review site visits with the Pathfinder Office®, Microsoft Excel® and Microsoft Access® programs and the GeoExplorer3®.

Creating Projects

When PathFinder opens, a Select Project dialogue box opens with a Default Project Name. Select New, which opens a Project Folders dialogue box. Entering a separate project name for different projects keeps things organized. Enter a project name (e.g., Wetlands) in the Project Name: space. Choose a directory such as *MyDocs/Wetlands* for the Project Folder: space and select OK. Whenever opening PathFinder, select the appropriate project.

Creating a Data Dictionary

A data dictionary created in PathFinder and transferred to the DataLogger prior to fieldwork determines the data recorded by the DataLogger. The DataLogger will collect data (aka: attributes) for each point (aka: feature) selected. An outline of the data required for each point prepared before creating the data dictionary expedites the process.

Open PathFinder and select the Project from the Select Project dialogue dropdown list. Select Utilities from the toolbar and Data Dictionary Editor from the dropdown list. The Data Dictionary Editor dialogue box will open. Enter a Name such as *Wetlands* and a Comment if wanted. Select New Feature and when the dialogue box opens enter a Feature Name such as *Project* and select Point as the Feature Classification and then OK. The Data Dictionary Editor will open with *Project* listed under Features.

The data to be gathered for each point is now entered as attributes, select New Attribute and the type when the New Attribute Type dialogue box opens. When you chose Menu, you need to enter an Attribute Name and then select New and then an Attribute Value name when the New Attribute Value – Menu Item dialogue box opens followed by selecting Add, repeat for each Attribute Value. For example, the Attribute may be *Seaweed Cover* and the Attribute Values may be *Heavy, Moderate* or *Light*. The addition of other types of Attributes such as Numeric, Date and Time are self-explanatory.

Data dictionary outlines prepared for wetland reviews and clam surveys are contained in the appendix.

Creating Waypoints

Waypoints are "position only" data points that can be created in PathFinder and transferred to the DataLogger or created in the field with the DataLogger. Waypoints can be used to locate positions in the field or mark a location for navigation purposes.

To create a waypoint, open PathFinder and select File from the toolbar and Background from the dropdown list. Follow the procedure in the section Adding a Background Map to display a map of a subject area. Use the Zoom tool (magnifying glass icon) to obtain the proper scale. Select File from the toolbar, Waypoints from the first dropdown list and New from the second. The New Waypoint File dialogue box will open. Choose a location for the waypoint file such as *MyDocs/Wetlands/PFData/Waypoints* (you will have to create this file the first time) in the Save in dropdown list. Use the default file name or a more descriptive one in the File name: block. Select OK. The Waypoint Properties dialogue box will open; select Create. The default name or another can be used in the Name box and North and East coordinates entered to create the waypoint. If the Pick From Map box is checked, the cursor can be used to pick off the waypoint from the map, selecting Save completes the operation and another Create Waypoint dialogue box will open. Select Close when done.

Transferring Files: PathFinder to DataLogger

Data Dictionary or Waypoint files will have to be transferred from the PathFinder program to the DataLogger prior to fieldwork. With the DataLogger in the cradle, open PathFinder and select Wetlands from the Select Project dialogue box dropdown list and OK. Select Utilities from the toolbar and Data Transfer from the dropdown list. The Data Transfer box will open listing Available Files on the DataLogger. Select the file to transfer and Add. The file will appear in the Selected Files list. Select Transfer and the files will be sent to a default directory or one of your choosing.

Collecting Data for One Feature

Upon arriving at the site of the fieldwork, power up the DataLogger, a satellite acquisition screen will appear. The DataLogger will take a minute or so to acquire available satellites. A minimum of three satellites is needed to log position data. When ready, press the Data button and a Collect New Data screen will appear. Check the Dictionary display to ensure it coincides with the particular project. It can be changed by using the arrow keys to highlight it then hit the Enter key; then again using the arrow keys and Enter key to select the correct dictionary from the Dictionary scroll down list. Highlight Create New File and select it with the Enter key. This will bring up the New Feature screen. You will be asked if GPS positions are to be logged now or later, use the arrow keys and Enter key to choose. If you are at a position that you want to log position data, select Now; a beeping icon in the lower right corner will indicate the number position data points being logged. If you are not in a position to log position data, select Later; a blinking pause icon will appear in the lower right corner of the screen, press the Log key to begin position logging when ready. Use the arrow keys and Enter key to scroll through attribute list and enter the appropriate data. When completed, hit the Log key to pause the position-logging feature. Power down to complete the operation.

Collecting Data for Multiple Features

When multiple features need to be recorded at a site, follow the procedures just described with the following exception. When position logging and data input are completed for the first

feature, press the Log key to pause position logging. Proceed to the next feature site. Press the Close key to save the data from the last feature; this will also open the New Feature screen. Continue this procedure for each feature. Press the Close key and power down to complete the operation.

Transferring Data: DataLogger to PathFinder

With the DataLogger in the cradle, open PathFinder and select Wetlands from the Select Project dialogue box dropdown list and OK. Select Utilities from the toolbar and Data Transfer from the dropdown list. The Data Transfer box will open listing Available Files on the DataLogger. Select the file to transfer and Add. The file will appear in the Selected Files list. Select Transfer and the files will be sent to a default directory or one of your choosing.

Differential Correction of Data

Select Utilities from the toolbar and Differential Correction from the dropdown list. The Differential Correction dialogue box will open with the transferred file listed under Rover Files: Selected Files. Select the file and Internet Search. The Internet Search dialogue box will open and show the current Base Data Provider, select OK. Select Yes on the Confirm Internet Setup dialogue box. A Confirm Selected Base Files dialogue box will open, select OK. A Reference Position dialogue box will open; select OK. The Differential Correction dialogue box will open with an entry under Base Files: Selected Files; select OK. A number of dialogue boxes will confirm correction.

View Data

Select File from the toolbar and Open from the dropdown list. The Open dialogue box will open with the *PFData* file in the dropdown list window. Select the file to view and Open. Select View from the toolbar and Map from the dropdown list. A project symbol will appear in the center of the map. Select Data for the toolbar and Feature Properties from the dropdown list, a Feature Properties dialogue box will open listing the attributes data collected in the field.

Adding a Background Map

To acquire a topo map, open the browser and go to the Maine GIS website. Select the 24 Tile tab and then the drgclip link. Select the Next tab, which will bring up the list of 7.5" series topographic maps for Maine. Select the appropriate map and then Show Data; the map will be shown as a ZIP file, select Download. A File Download dialogue box will appear, select Open. The file will download to a temporary file and the WinZip program will open. Follow the instructions to unzip the file. Rename the two unzipped files with the map name but leave the extensions the same and move the files to the directory: *MyDocs/Wetlands/PFData/Maps*.

To add the topo map as background, select File from the toolbar and Background from the dropdown list. The Load Background Files dialogue box will open. Select Add and the Add Background Files dialogue box will open with a list of background files in the *Maps* directory. Select the right file and Open; the file will then be listed in the Load Background Files dialogue box. Note: the GIS files are UTM coordinated, be sure the coordinate system listed in this dialogue box are Universal Transverse Mercator 19 North NAD 1983 HPGN (Maine), also select Options from the toolbar and Coordinate System from the dropdown list; the system, zone and datum should be the same, if not, change it. Close the dialogue box. If the background map does not show, select View from the toolbar and Zoom then Extents from the dropdown lists. Use View: Zoom: In/Out to view the map at different scales.

Plotting a Project Map

In map view with the background loaded and set to the desired scale, select File from the toolbar and Plot Map from the dropdown list. The Plot Map dialogue box will open; enter a Plot Title. Check the scale and select Grid type from the list. Select Preview to see how the map will appear, then Print. To change page orientation, select Close then Setup then Portrait or Landscape and OK.

Exporting to and Creating a Database

The data from each DataLogger file (feature attributes) can be exported into a database such as Access. Select Utilities from the toolbar and Export from the dropdown list, this will open the Export dialogue box. The current open file should be listed in the Input Files list and the Output Folder should show the following directory: *MyDocs/Wetlands/PFData/export.* From the Choose on Export Setup dropdown list, select Sample dBase Setup then OK.

To set up an Access database, open a blank Access database, which will bring up a File New Data Base dialogue box. Choose a directory to save the database to such as *My Docs/Wetlands/PFData/dBase* and choose a file name such as *Project* and select Create. A Project: Database dialogue box will open. Right click on the title bar and select Import from the dropdown list; this will open an Import dialogue box. Select the *MyDocs/Wetlands/PFData/export* directory and from the File Type scroll down list select dBase5. The file *Project.dbf* will appear; select it and Import. A Project icon will appear in the Project: Database dialogue box. Selecting the icon will open a database table with the project data.

Adding Data to an Existing Database

Once the database is created, adding data to it begins with the same process as described above in Creating a Database. Beginning with a DataLogger file, follow the above procedures in paragraph one. Open the Project database file found in the *My Docs/Wetlands/PFData/dBase* and right click on the title bar and select Import from the dropdown list; this will open an Import dialogue box. Select the *MyDocs/Wetlands/PFData/export* directory and from the File Type dropdown list select dBase5. The file *Project.dbf* will appear; select it and Import. A Project1 icon will appear in the Project: Database dialogue box along with the Project icon.

To add the Project1 data to the Project database for the first time select Queries from the Project: Database dialogue box and then select Create Query in Design view. On the Show Table dialogue box select Project1; select Add and Close. A Query: Select Query dialogue box will open. From the toolbox select Query then Append Query from the dropdown list; an Append dialogue box will appear, select Project from the Table Name dropdown list and OK. Select the asterisk from the Project1 scroll box and drag it onto the design grid just below it; it will automatically fill in the appropriate boxes. Select Query form the toolbar and Run from the dropdown list; this will add the data from Project1 to Project. Delete Project1 to complete the process.

After the Append Query has been created, adding data is simplified by skipping the direction of the preceding paragraph, selecting Queries from the Project: Database dialogue box and then double clicking the Query1 icon. Delete Project1 to complete the process.

PRODUCTS

The wetland alteration project review begins with a review request from the Department of Environmental Protection. The request contains a copy of the project application submitted to the DEP by the applicant. Once the reviewing biologist has an overview of the project, a site visit is scheduled at a convenient date around low tide. The purpose of the site visit is to better characterize the site in relation to marine resources, to make first hand observations of items and issues of concern, to discover opportunities for mitigation if needed and to report those findings to DEP in written comments.

Figure 1 is an example of the comments forwarded to the DMR Wetlands Coordinator for editing prior to submission to the Commissioner for signature and transmittal to the DEP. The comments contain the following sections: project information, project description, site description and project impact. The site description and project impact summarize the findings of the site visit and represent the reviewing biologist contribution to the departmental review. The site description is a narrative of the geologic environments of the shore from the immediate upland to the subtidal zone as well as the major flora and fauna. The project impact is a statement concerning negative effects to marine resources including fisheries and access.

The use of GPS and GIS add a couple of additional products to the standard review comments: a precise map of the project location and a database of the observed site parameters. Figure 2 is a map of the project described in the comments page (Fig.1). The map is produced with the Pathfinder Office software utilizing data obtained by the GeoExplorer3 during the site visit. The project location (spot where the proposed project crosses the high water mark) is shown as a red dot in the center of a 3.5-minute topographic map of the area at a scale of 1:10,000. Figure 3 is a form based on a query of an Access database created by importing database files from Pathfinder Office. This is one of many ways to display the site visit data obtained by the GeoExplore3. The form shows the 44 review attributes with the data of the sample visit displayed. Subsequent site visits can be exported from Pathfinder and added to a main database.

In addition to these products, Pathfinder database files can be exported as ARC/INFO or ArcView files for integration into the state GIS system.

CONCLUSION

With a history that goes back to the early 1980s, the State of Maine has been heavily invested in GIS for its data management needs. Many state agencies have taken advantage of the capability of GIS and the services of the Office of GIS. It is presumed, however, that there are many agency programs that could utilize and benefit from GIS but the lack of knowledge, vision or funding have stalled its adoption to a greater extent. Fortunately, these three elements came together at the DMR Watershed Bureau and this study was undertaken.

Once the appropriate hardware and software were obtained, it was necessary to integrate utilization of GPS and GIS into the existing site visit procedures. This required the development

of specific processes within the hardware and software. This was accomplished behind the desk and in the field over a couple of years and is documented in this report.

The work has resulted in an enhanced review process. The use of a data logging GPS supplants the clipboard, pencil and data sheets and with the GIS software eliminates data entry. The addition of accurate site maps to the review process and the ability to integrate the site visit data into the state GIS makes a GPS-GIS combination a great addition to the site visit toolbox.

Figure 1

State of Maine
Department of Marine Resources
MEMORANDUM

To: Brian Swan
From: Don Card
Re: Review Comments
Date: July 17, 2003

Wetlands Alteration Project Review

Project Information

Project #: 21373	Applicant: IF&W	Site Visit: ☑ yes ☐ no
Project: Boat Ramp	Analyst: Hallowell	Date: 07/17/03
Location: Brunswick	Reviewer: Card	

Project Description

The applicant proposes to develop an all tide boat launching facility including a 48' wide and 110' long ramp that will have two launch lanes with a center dock system made up of ten 8' wide and 20' long floats stabilized by pilings. The ramp will be constructed with engineered fill, a grooved precast concrete driving surface and riprap protected side slopes.

Site Description

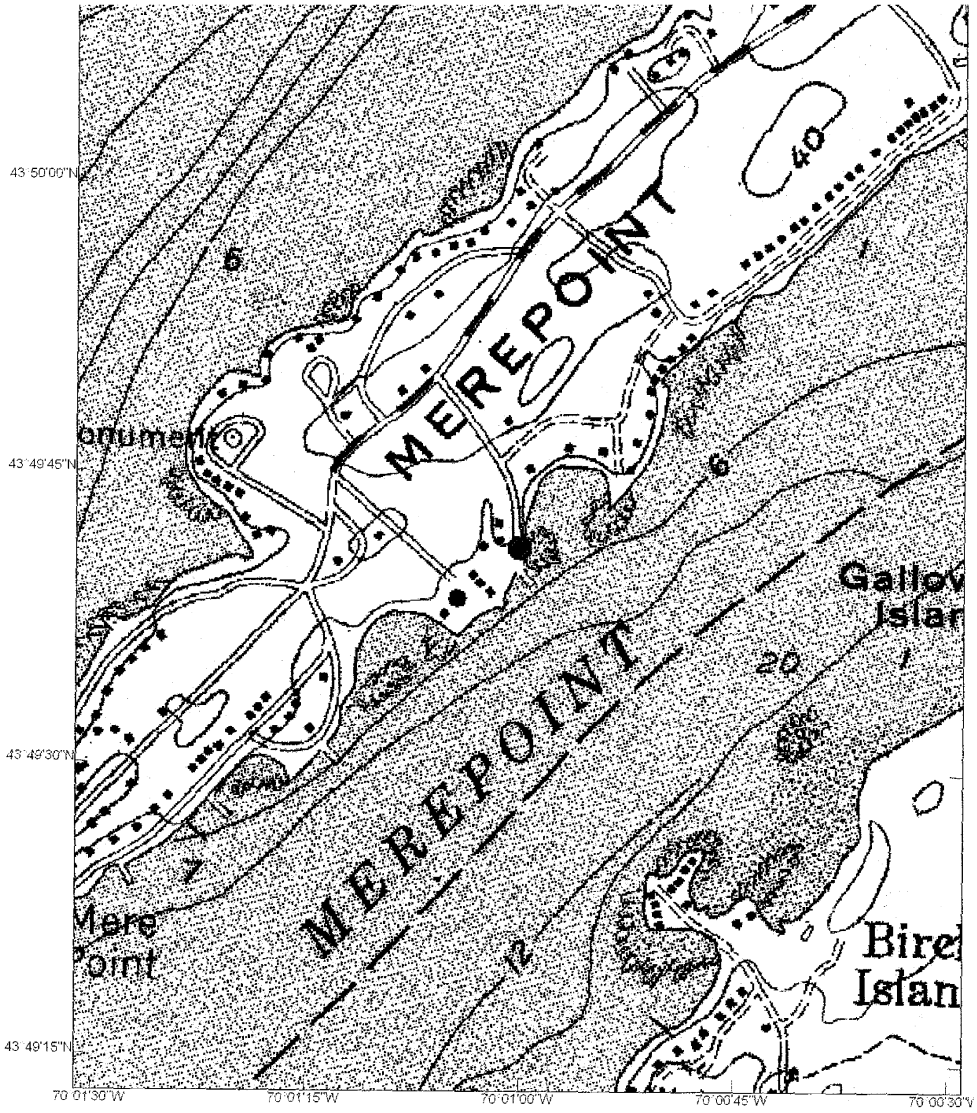
The site of the proposed project is a moderate energy mixed shore. The upland is partially developed with a road. The intertidal zone is approximately 100' wide with a variable slope. The supratidal is the base of a 10' high, vegetated and partially erosional bank. The upper intertidal is thatch, sand and gravel. The mid intertidal is predominantly ledge with pockets of sand, gravel and cobble. The lower intertidal is gravel and sand with some stone. The subtidal is primarily sand and drops of gradually to deeper water. There is a moderate seaweed cover on the hard substrate and a 12' wide fringing marsh. There are abundant barnacles; whelks and periwinkles are present and there are scattered soft-shell clams.

Project Impact

This project as proposed will result in the loss of the fringing marsh and the conversion of subtidal soft-bottom to rocky habitat. The mitigation plan should compensate for any losses. Navigation and recreation will not be impeded.

Note: The Wharton Point mitigation site should be better protected from ATV and 4x4 vehicle traffic (perhaps by the installation of an aesthetically pleasing fence just south of the gravel turn-around and parking area). The current degradation of the site was caused by this kind of traffic.

Figure 2


43° 50'00"N
43° 49'45"N
43° 49'30"N
43° 49'15"N
70° 01'30"W
70° 01'15"W
70° 01'00"W
70° 00'45"W
70° 00'30"W
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Wetlands Alteration Project 21373
Universal Transverse Mercator
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Scale 1:10000
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0.300
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r071712a.cor
11/20/2003
Pathfinder Office
Trimble

Figure 3

Wetland Alteration Project

Site Visit Data

DEP ID#	21373	Upland Character	Rural	Mid Intertidal 1st	Boulder	Seaweed Cover	Moderate
UTM East	418240.83	Upland Flora	Trees-Grasses	Mid Intertidal 2nd	Sand-Gravel	Eelgrass Cover	None
UTM North	4853289.872	Upland Landform	Bluff	Mid Intertidal 3rd	N/A	Barnacles	Abundant
Date	7/17/2003	Upland Height (ft)	10	Low Intertidal 1st	Gravel	Periwinkles	Present
Time	08:36:11AM	Upland Stability	Partially Erosional	Low Intertidal 2nd	Sand	Whelk	Present
Shore	Mixed	Supratidal 1st	Thatch	Low Intertidal 3rd	Stone	Clams	Scattered
Energy	Moderate	Supratidal 2nd	N/A	Subtidal 1st	Sand-Gravel	Mussels	None
Intertidal Width (ft)	108	Supratidal 3rd	N/A	Subtidal 2nd	Mud	Worms	None
Intertidal Slope	Variable	High Intertidal 1st	Sand-Gravel	Subtidal 3rd	N/A	Resource Impact	Minor
Intertidal Slope (o)	5	High Intertidal 2nd	Thatch	Emergent Flora	Low Marsh	Rec/Acc Impact	None
Upland Develop.	Partially Developed	High Intertidal 3rd	Ledge-Boulder	Marsh Width (ft)	15	Notes	No

Additional Notes

Table 1

Wetlands Data Dictionary

Point Feature: Project

Attribute	*NumericlMenu*
DEP ID Number	[# # #]
Date	[auto]
Time	[auto]
Shore	[Rocky | Unconsolidated | Mixed | Man Made]
Energy	[High | Moderate | Low]
Intertidal Width	[# #]
Intertidal Slope	[Uniform | Variable]
Intertidal Slope (°)	[##]
Upland Development	[Developed | Partially Developed | Undeveloped]
Upland Character	[Rural | Rural-Residential | Suburban | Urban]
Upland Vegetation	[None | Trees | Shrubs | Grasses | T+S | S+G | T+S+G]
Upland Landform	[Cliff | Bluff | Bank | Slope]
Upland Stability	[Erosional | Partially Erosional | Stable]
Supratidal 1-3	[Ledge | Boulder | Stone | Cobble | Gravel | Pebble | Sand | Silt | Clay |Thatch | Ledge-Boulder | Sand-Gravel | Mud | Riprap | Man Made: stone | MM: wood | MM: metal]
Upper Intertidal 1-3	[" " " " " " " "]
Mid Intertidal 1-3	[" " " " " " " "]
Lower Intertidal 1-3	[" " " " " " " "]
Subtidal 1-3	[" " " " " " " "]
Emergent Vegetation	[None | High Marsh | Low Marsh | High + Low Marsh]
Marsh Width	[# #]
Seaweed Cover	[None | Heavy | Moderate | Light | Sparse]
Eelgrass Cover	[None | Heavy | Moderate | Light | Sparse]
Barnacles	[None | Scattered | Present | Abundant]
Periwinkles	[" " " "]
Whelk	[" " " "]
Mussels	[" " " "]
Clams	[" " " "]
Worms	[" " " "]
Impact- Resources	[None | Major | Minor]
Impact- Rec/Nav	[None | Major | Minor]
Notes	[Yes | No]